Planetology

Mars Pathfinder Virtual Reality Model (MarsMap)

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Researchers at Ames Research Center (ARC) provided Pathfinder Mission scientists at the Jet Propulsion Laboratory (JPL) with three-dimensional (3-D) digital topographic models and an advanced interface for interaction with the virtual environment of the Martian surface. Because of the photographic realism of the 3-D models, scientists were able to learn more quickly about the Pathfinder landing site than they could have from a static view of the rock field that surrounded the lander. The virtual reality aspect of the display allowed them to move around the field, even to project a bird's eye view from above it. Moreover, 3-D measurements of positions, distances, and angles could be easily extracted from the topographic models, providing valuable tools for science analysis and mission planning.

Images of Mars captured by the Imager for Mars Pathfinder (IMP) stereo camera aboard the Pathfinder spacecraft were relayed to JPL through the Deep Space Network. After initial downlink of the images, an automated file-transfer protocol system sent the digital information through the Internet to Ames Research Center, where the 3-D models were rapidly processed by the stereo pipeline. A computer algorithm automatically matched features in a left-eye camera image with the identical features in a right-eye camera image, thus providing the necessary correspondence to compute a 3-D location for that image pixel.

Immediately following processing, the 3-D models were transmitted from ARC through the Internet back to computers at JPL for display in the Science Operations Center, using "MarsMap," a 3-D virtual reality interface for the scientific exploration of Mars. A significant achievement of the stereo pipeline was the total turnaround time of model production and display for the Mars Pathfinder Mission. For the first set of IMP stereo images returned from the surface of Mars, scientists at JPL were able to virtually fly through the 3-D Martian landscape within 15 minutes of receipt of the downlink data at JPL.

Beyond its spectacular visualization capabilities for navigating Mars in 3-D by using stereo eyewear and virtual reality goggles, MarsMap provided the Pathfinder Operations Team with a valuable tool for performing science analysis and mission planning. After the arrival of Pathfinder on Mars, MarsMap was used to verify the angle of the rover ramps for safe deployment, to generate 3-D pointing coordinates for IMP imaging sequences, to determine positions and sizes of rocks at the landing site, to measure the direction of wind tails behind the rocks, and to locate and display other science data markers on the topographic map of Mars.

Another important use of MarsMap was in assisting with past archiving and future planning of Sojourner traverses through the Martian landscape. A virtual model of the Sojourner rover was placed in the 3-D topographic map to show the history of the rover journey on the surface of Mars. Images captured by Sojourner were also integrated into the 3-D model as 2-D "billboards" projected from a virtual camera in the model. When faced with a potentially tight fit between rocks, an operator could use the same virtual model of the rover to determine if the real rover had suitable clearance for the maneuver. The accompanying image shows Sojourner looking at the side of the rock named "Yogi."

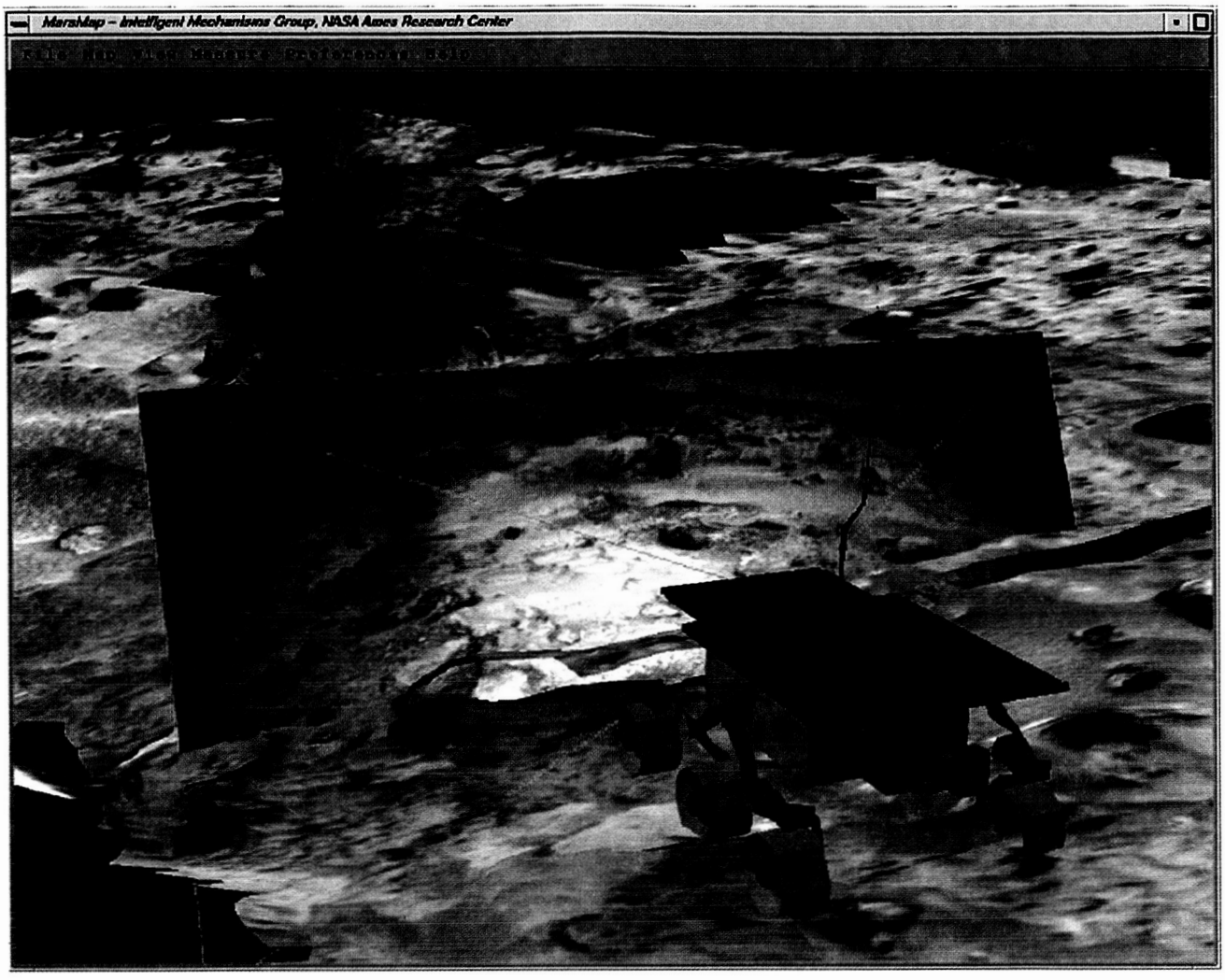

Fig. 1. A computer-generated image from the virtual reality software MarsMap shows a perspective view of the large rock "Yogi" in the background. Analysis of the steep overhang of this rock using MarsMap was instrumental to the successful navigation of Sojourner during the Pathfinder mission. A rover image and CAD model are also projected into the 3-D scene and substantiate the steep overhang predicted by the virtual reality model.

MarsMap was also used quite extensively for the Pathfinder Mission as a visual cataloging tool. Data markers such as 3-D text symbols were superimposed on the terrain model to indicate the sequence of Alpha Proton X-Ray Spectrometer measurements taken by the Sojourner rover, soil mechanics experiments, and other science-related events. These data markers assisted mission scientists in keeping track of the past activities of Sojourner, as well as planning for future events.

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